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REPORT

ON THE

DARANGGIRI COALFIELD,

IN THE

GARO HILLS, ASSAM,

BY

PROFESSOR W. GALLOWAY, F.G.S.

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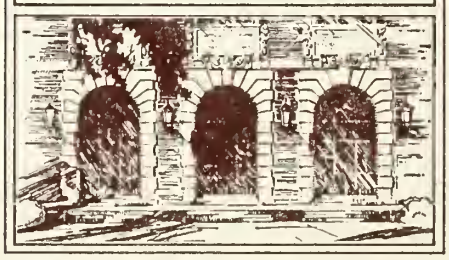

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A REPORT

ON THE

DARANGGIRI COALFIELD,

IN THE

GARO HILLS, ASSAM,

BY

Professor W. GALLOWAY, F.G.S.

CARDIFF,

30th March 1904.

DEAR SIR,

The existence of this Coalfield has been known since the Revenue Survey Maps of Mymensingh were made, the Surveyors engaged in that work having first drawn attention to it, and marked its approximate position on their maps. It lies on both sides of the river Sumasery, and its position relative to that river is shown in No. 1 Plan.

It contains one thick and several thin seams of coal, of which the thick seam alone is worthy of consideration in the present report.

The river Sumasery runs through this area first in a north-easterly direction to its junction with the Renchi, then due north to its junction with the Rongwi, and finally in a westerly direction until it passes out of the coal-bearing ground.

The surface of the coal-bearing area consists for the most part of a series of irregular hills and terraces, with steep, and in many places precipitous, sides towards the Sumasery and its tributaries, above which the hills and cliffs rise to an elevation of 300 to 500 feet. Immediately to the north of Siju a bold ridge, 1,000 or 1,200 feet high, runs in a west-north-west, east-south-east direction, and extends far beyond the limits of the Coalfield on both sides.

GEOLOGY.

The ridge just referred to consists of a belt of gneiss which, measured at right angles to its axis, extends from near Siju to near Baduri, see No. 1 Plan. The coal-bearing strata, which are of Cretaceous age*, rest upon a floor of gneiss on each side of the ridge.

* Records of the Geological Survey of India, Vol. I, Pt. 1, p. 11 ; Vol. VII, Pt. 2, p. 58 ; Mem. G.S.T. Vol. VII, p. 151 ; Records, Vol. VII, Pt. 3, and Vol. XX, p. 40.

The following approximate section of these strata as they occur at Daranggiri is given by Mr. T. D. LaTouche † :—

		FEET.	INCHES.
1.	Coarse yellow and brown sandstones	240	0
2.	White sandstone, with bands or shaly clay rock ...	70	0
3.	Coal	1	0
4.	Shaly clay rock	3	0
5.	Coal	0	10
6.	Shaly clay rock	4	0
7.	Coal	0	6
8.	White sandstone, with bands of shale	20	0
9.	Coal	7	6
10.	Sandy shale, with strings of coal in lower part ...	5	0
11.	Coal	1	0
12.	Carbonaceous sandy shale	5	0
13.	Coal	1	0
14.	Carbonaceous shale, base hidden under water ...	1	0
		358	10

Mr. LaTouche continues as follows :—"In this section the beds immediately below the coal are not exposed, but on following down the stream the rise of the strata gradually brings them up until, at a short distance above the junction of the Rongwi (Nongwal) with the Sumasery, they are seen resting directly upon the gneiss, and consist of about 200 feet of coarse purple and yellow grits and conglomerates."

According to Mr. LaTouche, therefore, the coal-bearing beds are about 570 feet thick, *viz.* :—About 258 feet above the main seam of coal, and 212 feet below it.

Referring to another section at the east side of the Sumasery, the same author says at p. 177 :—"A good section is exposed in the Nenja stream (see the point N on No. 1 plan) a small tributary of the Renchi, about one mile from the latter as follows." :—

		FEET.	INCHES.
1.	Coarse sandstone	12	0
2.	Coal, about	3	6
3.	Clay rock, with carbonaceous markings	4	0
4.	Fine yellowish brown sandstone	4	0

"The beds are horizontal."

The first section is near the extreme west, the second at what I shall here treat as the extreme east of the field, although it will be seen from No. 1 Plan that the Cretaceous beds extend many miles further eastwards than that point. The thickness of the main seam in the last section is given as only 3 feet 6 inches. As will be seen later, however, its thickness at the point L in the Sumasery valley is 7 feet, so that its thinning to 3 feet 6 inches, if it actually occurs, must take place between that point and the Nenja and not gradually all the way from Daranggiri as Mr. LaTouche assumes.

† Records of the Geological Survey of India, Vol XV, Pt. 3, p. 176.

I saw and examined the gneiss on the ridge above Siju and in two localities in the bed of the Sumasery, namely, at its junction with the Nongwal, and in its N. S. reach about a mile above its junction with the Renchi. At the former point (see photographs 1 and 2) I found it to consist of a very hard quartzose rock with minute scales of mica, intersected by numerous veins of quartz, granite, and coarsely crystallised flesh-coloured granulite. Its weathered surfaces are black, smooth and rounded, but when broken it produces a grey powder. The further and nearer sides of the pool in the foreground, which is seen extending from left to right in No. 1 photograph, are the walls of two parallel veins of granite, one three, the other four feet thick There is a third vein about two feet thick in the middle between them. The same three veins are seen on the opposite bank of the Sumasery, on the right band side of, but beyond, the photograph. No. 2 photograph is taken from the same point as No. 1, but looking down the river instead of up. The Nongwal river joins the Sumasery just behind the boss of gneiss in the foreground of No. 2.

The gneiss in the bed of the Sumasery above Jankary presents exactly the same appearance as that described above, but here some of the bosses rise to a height of 30 or 40 feet above the level of the water in the river. It stretches along the river bed for upwards of a mile (see No. 1 Plan). The stratified rocks which flank both sides of the river are hidden from view by the jungle along the whole of this distance. The beds of the rivers Nongwal and Sumasery are covered with rounded boulders of gneiss, granite, and other eruptive rocks which have been carried down by floods from beyond the edges of the coalfield. Amongst these are many angular and subangular fragments of sandstone, shale, and claystone derived from the Cretaceous rocks especially near those points at which the vertical cliffs come close to the river.

Between Siju and Baduri the ridge of gneiss is capped with patches of Cretaceous rocks on its slopes and summits. It appears to have been raised into its present position by lateral compression, which gave rise to folding, contortion, and crushing of the stratified rocks in immediate contact with it.

I saw the seam only at one point on the south side of the ridge near Siju (No. 2 Plan) and (No. 3 Photograph) where it is crushed out of its original shape and practically vertical. Owing to this cause it is 8 feet 2 inches thick on the level on which the native is standing, and only 3 feet thick at the top of the photograph. At a distance of about 100 feet westwards from this outcrop, two seams, each about a foot or fifteen inches thick, with a bed of hard clay about 4 feet thick between them, crop out in the bed of the Sumasery. This double seam is also vertical. There are two other reputed outcrops of the main seam marked on No. 2 Plan which I did not see, and was not informed about, at the time of my visit to the coalfield. Their position on the plan shows that they are on the southern edge of the ridge, and therefore close to, or within, the region of disturbed ground, referred to above. On the opposite side of the Sumasery, at a distance of 200 or 300 yards from this outcrop, the stratified rocks are nearly horizontal (No. 2 Plan). They continue on both sides of the Sumasery all the way down to Rywak, being horizontal in some places, undulating in others. This part of the Sumasery was visited and described by Mr. H. B. Medlicott in 1868* ; but Mr. Medlicott did not, at that time, get beyond the village of Siju for want of sufficient escort, and consequently saw none of

* Records of the Geological Survey of India. Vol. I, Pt. 1, p. 11.

the outcrops on the north side of the ridge in the Daranggiri part of the field, until he examined it in 1874. In 1868 he found a seam of coal three feet thick, and a good deal crushed, somewhere between Rywak and Siju, which he describes as being similar to, and undoubtedly the southward continuation of, the Siju seam. I am of opinion that the main seam will be found in the ground on both sides of the river all the way down to Rywak, but as a bed of nummulitic limestone belonging to the Lower Tertiary, which immediately overlies the Cretaceous formation, occurs in the bed of the river at a distance of 200 or 300 yards west of the outcrop of the seam at Siju (No. 2 Plan), dipping southward at an angle of about 10°, the seam itself must here lie at a depth of over 200 feet below water level. I did not observe its reappearance above water level anywhere on the side of the river between Siju and Rywak.

On the north side of the ridge, at the point O (Nos. 1 and 3 Plans) close to the village of Baduri, the seam is level; in the Rongmudu Valley (Nos. 1 and 4 Plans) it dips at the rate of 3° from the point E in the direction 52° S.E. for about 1,700 feet; from the same point the outcrop is visible at the opposite side of the valley, at a distance of about 2,000 feet, and the dip between these two points is 1° in the direction 27° S.W.; from the point F (No. 4 Plan) on the opposite side of the valley, the outcrop is seen for a distance of 1,000 feet along the face of the cliff, and its dip is 2° in the direction 88° N.E.; along the west bank of the Nongwal (No. 6 Photograph) it is visible for 600 feet between, and on the both sides of the points B and C, and its dip here is 1° in the direction 65° N.E.; near the point A (No. 7 Photograph) it is visible for about 200 feet along the river's edge, with a dip of $3\frac{1}{2}$° in the direction 45° S.E.

From the last two observations it will be seen that a synclinal axis passes between the points A and B. After passing this axis the seam continues to rise northwards towards the junction of the Nongwal and Sumasery rivers. Its outcrop is visible for a distance of some hundreds of feet along the face of the cliff on the west bank, and for over 2,000 feet along the face of the cliff on the east bank of the Nongwal, in both cases at a height of over 200 feet above the level of the river. The outcrop on the east cliff is well seen in No. 4 photograph, taken from near the Dâk bungalow at the junction of the Nongwal with the Sumasery, and in No. 5 photograph taken from a point in the bed of the Nongwal, 400 or 500 yards further south than the last. The main seam, apparently about 8 feet or more in thickness, and the double seam about 100 feet below it, are both continuously visible.

From the debouchure of the Nongwal the seam dips slowly eastwards and passes under the bed of the Sumasery at the point F (No. 1 Plan), about a quarter of a mile on the west side of the junction of that river with the Rongmu.*

I was unable to see this outcrop for want of canoes, but I proceeded up the bed of the Rongmu to the point K, and found the seam emerging from under the water with a dip of $4\frac{1}{2}$° in the direction 80° S.E. Its outcrop is here exposed for a distance of over 100 feet on the west side of the stream. Northwards from this point it is hidden by debris and vegetation, but is said to extend to a distance of several miles along the cliffs on both sides of the river.

* Records of the Geological Survey of India, Vol. VII, Pt. 3.

Proceeding down the Sumasery from the last point the seam continues below the level of the river for a distance of 1½ or 2 miles. It emerges at L with a dip of 7° in the direction 19° N.W., and from this point continues to rise towards the south, and is seen in the cliffs on both sides. At a distance of about 400 yards below its point of emergence a second seam, 100 or 120 feet below it and apparently about the same thickness, is seen in the east cliff and a little lower down also in the west cliff. I assume this to be a local thickening of the two seams of coal, and a thinning out or disappearance of the bed of claystone which, taken together, constitute the three members of the double seam seen at Siju and in the cliffs near Daranggiri and Jankary.

About 300 or 400 yards still further down the river the gneiss, with veins of granite quartz and granulite as before, appears in the river bed, and continues for a distance of about a mile. It rises at numerous points in black rounded and angular bosses to a height of 30 or 40 feet above the level of the water. All along this part of the river the stratified cliffs are hidden from view by vegetation, but about a quarter of a mile above the Dâk bungalow both cliffs again come into view, the east cliff about 150 yards, the west about 700 or 800 yards distant. In the east cliff the seam appears to be over 10 feet thick, and at a depth of 100 feet or so below it the double seam, consisting at this point apparently of dark shale 3 or 4 feet thick, with a thin seam of coal above, and another below it is again distinctly seen. The main seam is very clearly exposed for a distance of 1,200 or 1,500 feet in the east cliff from which the debris and the vegetation growing upon it have recently fallen (M, No. 1 Plan). It is about 300 feet above the river where it is quite unapproachable on account of the steepness of the cliff. It appears to be practically level. The Dâk bungalow opposite this cliff is about half a mile above the Junction of the Kenchi river with the Sumasery, and on the west bank of the latter.

No. 8 photograph is a view of the east cliff taken from a bamboo raft on the river a few hundred yards above the Dâk bungalow. No. 9 is a view of the same cliff taken from the Dâk bungalow itself.

This outcrop was the last which I saw on the east side of the field, but Mr Tom D. LaTouche * describes the outcrops eastwards from the Sumasery, and shows by means of the map which accompanies his paper (from which No. 1 Plan is compiled) that the seam extends to a distance of several miles in that direction. I am confident that the seam one foot thick, which he saw on the Rongtok, is not the continuation of the main seam in that direction, and I suspect that the 3 feet 6 inch seam on the Nenja may be only a thickening out of one of the thin seams, or a local thinning of the principal seam. I will, however, for want of proof to the contrary, assume it to be normal.

THICKNESS OF THE SEAM.

At Siju the seam varies from a thickness of 8 feet 2 inches on the ground level to about 3 feet at the highest point exposed in No. 3 photograph.

A short heading that had been opened in it to a depth of 5 feet enables me to judge of its condition and ascertain its thickness much more accurately than I could have done otherwise, and similar headings opened at Baduri and and Daranggiri, of which figures 1 to 9 are sections were of equal service in this respect. (See Plans 2, 3 and 4.)

* Supra cit.

The thickness and condition of the seam in the various sections referred to are as follows :—

O (Fig. 1, Plan 3) 6 feet above river ; good clean coal 8 feet 2 inches thick ; practically level ; roof, white sandstone ; floor, hard grey fireclay.

A (Fig. 2, Plan 4) 10 feet above river ; good clean coal 6 feet thick ; roof, hard white claystone 4 feet thick, with a thick sandstone bed above it ; floor, hard rock.

B (Fig. 3) 25 feet above river ; good clean coal 7 feet 10 inches thick.

C (Fig. 4) 30 feet above river ; good clean coal 7 feet 11 inches thick ; roof and floor the same as B.

E (Fig. 5) 200 feet above river ; good clean coal 6 feet 8 inches thick ; roof, hard white claystone 5 feet thick, with rock above it.

F (Fig. 6) 245 feet above river ; good clean coal 11 feet thick ; for a distance of 100 feet westwards from this gallery the outcrop of the seam has apparently been on fire, as the ground above it is reddened and the seam and its roof are irregular.

D (Fig. 7) 50 feet above river ; good clean coal 5 feet 8 inches thick ; sandstone roof ; clay floor 6 inches thick, then sandstone.

G (Fig. 8) 25 feet above river ; good clean coal 6 feet thick ; sandstone roof ; clay floor 4 inches thick, then sandstone.

H (Fig 9) 12 feet above river ; good clean coal 8 feet 6 inches thick ; sandstone roof and floor.

K (Fig. 10, Plan 1) good clean coal 8 feet 4 inches thick ; roof, 4 feet of hard white claystone ; floor, very hard coarse sandstone.

L (Fig. 11) 80 feet above river ; good clean coal 7 feet thick ; roof, sandstone ; floor, hard white claystone.

According to Mr. LaTouche, the thickness of the seam at its outcrop on the Nenja at N is 3 feet 6 inches thick.

From these details the average thickness of the seam in the Daranggiri field is as follows :—

	FEET.	INCHES.
1. In the Rongmudu		
Fig. 5	6	8
Fig. 6	11	0
Total	17	8
Average	8	10
2. In the Nongwal		
Fig. 2	6	0
Fig. 3	7	10
Fig. 4	7	11
Fig. 8	6	0
Fig. 9	8	6
Total	36	3
Average	7	3

		Feet.	Inches.
3. On a north-east line O, K, between Baduri and the Rongmu River			
Fig. 1		8	2
Fig. 10		8	4
Total		16	6
Average		8	3
4. In the N. S. reach of the Sumasery above Jankary			
Fig. 11		7	0
5. On the Nenja		3	6

QUANTITY OF COAL IN THE FIELD.

The average between the thicknesses found in the Rongmudu and the Nongwal is 8 feet 1 inch ; between the Nongwal and the N.E. line O to K, from Baduri to the Rongmu 7 feet 9 inches ; between the line O, K, and the line P, Q, 7 feet 7½ inches ; and between the line P, Q, and the east outcrop at N, 5 feet 3 inches. It will be safe, therefore, to take 7 feet 6 inches as the average thickness west of the line P, Q, and 5 feet as the average thickness east of that line.

According to Mr. LaTouche* the area of coal available for working is 20 square miles. By actual measurement I find it to be 22 square miles, but I accept Mr. LaTouche's area and divide it into two parts, one west of the line P, Q, with an area of 15 square miles, the other east of the same line with an area of 5 square miles.

Taking 1,200 tons per foot thick per acre, after allowing for waste in working, this gives—

	Tons.
West of the line P, Q, ...	86,400,000
East of the line P, Q, ...	19,200,000
Total ...	105,600,000

Mr. LaTouche* estimated this area to contain 70,000,000 tons. In arriving at this quantity, however, he took the average thickness between Daranggiri and the Nenja. He had evidently not seen or measured the outcrop in the north south reach of the Sumasery at L, and this undoubtedly accounts for the difference between his figures and mine.

We have thus practically 100,000,000 tons of coal to work, or sufficient to last for 100 years at an output of 3,000 tons per day, without taking into account the outliers to the east and south-east of the Daranggiri area, or the ground between Siju and Rywak, from which the life of the coalfield will unquestionably be greatly prolonged beyond the period named above. In the Daranggiri field, only a comparatively small area of the field round about the junction of the Rongdi with the Sumasery (a point from which the seam appears to rise in every direction) lies below water level. See also Appindix I.

QUALITY OF THE COAL.

Like all seams of coal found in formations younger than the carboniferous which have not undergone metamorphic action, the coal in the Daranggiri field is what may be described as highly bituminous. This is apparent from the analyses given by Mr. LaTouche,* who cites those of five samples, two taken from

* Supra cit.

the outcrop of the principal seam, one at Daranggiri the other on the Nenja ; one found on a hillside, one on a talus of debris ; and the fifth from the outcrop of a seam 1 foot thick in the Rongtok near Jankary. As the three last tell us nothing regarding the principal seam, and as they do not correspond with its composition in any respect I omit them.

The two first are as follows :—

	Daranggiri.	Nenja.
Moisture	11·5	6·2
Volatile Hydrocarbons ...	33·1	39·4
Fixed Carbon	47·7	51·8
Ash	7·7	2·6
	100·0	100·0

When I visited the coalfield in February last, I made stone fireplaces at Siju, at Daranggiri, and at the Rongmudu Dâk bungalow, and burnt large samples of coal from the faces of the short headings that had been driven at the two first places, and from the outcrop in the Rongmudu River at the last. The fireplaces consisted of a layer of fairly large stones placed on the surface of the ground, with spaces between them through which air could penetrate to almost every part of the bottom of the fire which rested upon them. The coal on the fire was further supported round about its periphery by a row of stones resting on the outside stones of the bottom layer.

The coal ignited readily and burnt briskly with a long yellow to white flame. After having burnt for some time, the centre of the fire consisted of a white glowing mass of coked coal, in pieces which did not cohere together. These continued to glow until only a comparatively small quantity of greyish white ash remained.

For the purposes of analysis I took average samples of the seam from the faces of galleries A, B and E, *each of which represented the whole thickness of the seam*, one from the middle of F and H, respectively, and one from the point A on the outcrop K (Fig. 10) in the Rongmu Valley, and analysed them on my return to Cardiff, with the following results :—

	Calorific value.	Moisture.	Volatile Hydro-carbons.	Fixed Carbon.	Ash.	Sulphur.
1. A ...	6,954	8·90	41·40	46·96	2·44	...
2. B ...	6,770	10·35	39·95	46·38	3·32	...
3. E ...	6,910	7·80	41·75	47·33	3·12	...
4. F ...	6,890	9·35	40·75	47·85	2·05	...
5. H ...	7,022	8·80	41·40	46·77	3·03	...
6. K ...	6,360	12·70	37·10	47·14	3·06	...
Mean ...	6,818	9·65	40·40	47·09	2·85	...
Mixture of the six samples.	6,848	9·70	39·60	47·82	2·88	3·24

See Appendix IV.

The average calorific value of the first five samples, which were obtained from short headings in the outcrop, is 6,909. The calorific value of the sixth, K, which was taken from the weathered surface of the seam at its outcrop is 6,360, and its moisture 12·70 per cent. It would appear, therefore, as might also be inferred from *a priori* reasoning, that as the headings are extended inwards the calorific value will increase and the moisture decrease to some extent.

I add, for comparison, the average calorific values and the average contents in ash of the coals produced in the various coalfields of Assam, Bengal, and the Central Provinces, whose analyses are given in Professor Dunstan's Report.* The position of these coalfields are shown on No. 5 Plan. The table contained in that report would have been more useful if the author had indicated those analyses which represent the quality of the seams from which large outputs are now being obtained or will be obtained in future. I give only the calorific value and the ash, the former because it determines the evaporative value of the coal, the latter because it has an important bearing upon the rate of combustion and the cost of stoking.

Name of District.	Number of Samples.	Average Calorific Value.	Average Ash.
Assam (Makum)	2	7,079	2·34
Bengal	53	6,473	12·42
Central Provinces	13	5,513	14·60

METHOD OF WORKING.

By far the larger proportion of the seam is above water level, and can be worked by means of headings driven in from the outcrop at as many points as may be desired. Before workings are commenced a systematic plan should be drawn out showing the area allotted to each heading, the positions of parallel headings, cross-headings and working places, the method of ventilating the headings and the workings connected with them, the direction of haulage, the position of the railway siding, or other means of conveying the coal from each heading to the main line at the surface and so on.

As the greater part of the field is level the main headings should be driven level course, and the cross-headings in perfectly straight lines to the rise and dip. The haulage in the main headings, and where feasible also in the cross-headings, should be effected by means of electrical locomotives.

It will be found best, probably, to divide the workings into panels, by leaving pillars of 25 to 30 yards wide on each side of each main heading, and to work out the coal in the panels according to some system of pillar working. The working places should be made wider or narrower according to the kind of roof encountered at any given point. For instance, there is a thick bed of sandstone, which is always a good roof, overlying the coal and frequently resting upon it directly; but at some points, as will be seen in the Sections 1 to 11, a strong white claystone comes in between the sandstone and the coal.

* Imperial Institute of the United Kingdom, the Colonies, and India. Report on the Coal Supply of India by Professor Wyndham R. Dunstan, M.A., F.R.S., 1898.

At the outcrop the claystone is brittle and disjointed, but it will probably become strong and cohesive when the workings reach more solid ground. If not, it will either require to be supported by leaving a portion of the upper part of the seam for a roof, as shown in the sections of some of the headings (Figs. 3, 4, 6 and 9), or by means of timber, or it will require to be taken down especially in the main headings.

COST OF WORKING.

From what I have learnt of the cost of working coal in Bengal and Assam I am of opinion that the coal in this seam will be worked and delivered into railway wagons at the surface at a cost not exceeding Rs.* 1·8 (2s.)per ton, including a royalty of Rs 0·1 (1d.), payable to the Government of India. This low estimated cost is due to the small wages for which native miners can be obtained, namely, from 6d. to 8d. per man per day.

COST OF MACHINERY AND PLANT.

I estimate the cost of the buildings, plant and appliances required at the Colliery to be as follows :— Electrical locomotives and electrical hauling, pumping and ventilating engines, dynamos, cables, motors, hauling gear, ropes, pullies, pumps, fans and boilers, delivered and erected £20,000. Steam turbines with condensing pumps (either Laval's or Parson's) will be the simplest form of engine to employ and the most easily manipulated and kept in repair. Water-tube boilers (Babcock & Wilcox type) will be the best form of boiler on account of its being easily transported and kept in repair. Centrifugal pumps actuated by motors will be required to raise water out of local hollows in the workings. Rateau and Mortier ventilating fans, both of comparatively recent invention, are now being largely employed and are found to give excellent results. It would be as well to prepare for a ventilating current of 100,000 cubic feet per minute, which, at a pressure of 1 inch of water, would require 25 horse power, assuming the fan to work with an efficiency of 60 per cent. Miners' tools may be set down at £2,000. Rails and sleepers, 6,000 yards of railway or 12,000 yards of single rail at 25 pounds per yard, 134 tons at, say, £10 per ton delivered, £1,340 ; 6,000 sleepers at 8d. each, £200 ; Fish plates, spikes, &c., £50 ; 300 sets of points and crossings at £3, £900. The cost of mine wagons varies according to the load carried. They are used of all sizes from 8 cwt. up to 3 tons: 10 cwt. is the general load in Germany, 8 to 15 cwt. in England and Scotland, 1 ton to 2½ tons in South Wales, 2 to 3 tons in in the United States. A well-made wagon of this kind, with a body of sheet steel capable of carrying 1 ton, would cost about £10, delivered at the mines. Each wagon will make about 1½ trip per day, so that for an output of 1,000 tons per day 660 wagons will be required, costing £6,600. The rail gauge should not exceed 2 feet, and the wheels, say 15 inches in diameter, should be fixed on the axles.

In addition to the above, it will be necessary to have well-equipped smiths', carpenters', and fitters' shops, repairing shops for the mine wagons, stores, and an office, costing together with their tools and equipment, say £6,000. Plenty of stone, limestone, and timber suitable for the buildings are to be found close at hand.

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*1 Rupee = 1s. 4d.
1 Anna = 1d.

I estimate he cost of the equipment required at the Colliery to be as follows :—

	£
Machinery and Boilers	20,000
Miners' Tools	2,000
Underground Railways	2,500
Mine Wagons	6,600
Loading Bank and Approaches	2,000
Shops and Stores	5,000
Officials' and Miners' Houses	7,000
Cost of collecting 1,500 Coolies	10,000
	£55,100

MEANS OF TRANSPORT.

It will be necessary to construct a railway from some convenient point in the coal-field, say from near the Dâk bungalow at Jankary to a point on the Soorma river which constitutes the eastern boundary of the District of Mymensingh. Until the ground has been surveyed, it will be impossible, of course, to lay down the exact position of the intended railway on a map, but at present the most feasible route (No. 6 Plan) seems to be as follows :—

From near the Jankary bungalow on the west bank of the Sumasery through the gorge of the river to Siju—this will be the most expensive part, and some rock cutting, if not tunnelling, will be necessary ; from Siju to Rywak with a tunnel of about 200 yards through a sandstone cliff, just below Siju, which rises vertically from the edge of the water to a height of 80 or 100 feet at places ; from Rywak to Bagmari, and thence to Durgapur will be comparatively easy, and from Durgapur to the loading stages on the river will be on level ground, with only two or three short bridges. This route follows the right bank of the Sumasery all the way to Durgapur, and thereafter strikes a little more to the south-east. It is intended to employ a 2 feet 6 inches gauge (the gauge approved of by the Government of India for this type of railway), and to use rails of 41½ pounds per yard, and sleepers of Sâl wood, which resist decay as well as the ravages of the white ant.

The actual cost of a railway of this description with a gauge of 1 Metre, namely, the Mymensingh-Jagannathganj Extension Railway, constructed by the India General Steam Navigation Company was £ 1,600 per mile.

Making a liberal allowance for the windings of the river Sumasery, the length of the proposed railway will be 57 miles, and as no estimates based on actual survey are available, a liberal estimate of its cost is as follows :—

Section.	Length.	Cost per mile.	Cost of Section.
	Miles.	£	£
Jankary to Rywak ...	5	10,000	50,000
	10	6,600	66,000
Rywak to Durgapur	12	3,300	39,600
Durgapur to loading staiths or Durgapur to Mymensingh on E. B. S. Railway.	30	3,300	99,000
Total ...	57	.....	254,600

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AT URBANA-CHAMPAIGN

These prices include land, formation, bridges, permanent-way, rolling-stock, stations, workshops, machinery and all other expenses until the line is opened. The routes which the coal will subsequently follow by water carriage to Calcutta and Chittagong are distinctly shewn by red dotted lines on No. 6 Plan.

MECHANICAL PREPARATION.

It will be best to convey the coal as it comes out of the mine to the point of embarkation before preparing it for the market. Although the coal is, for the most part, hard and strong, it will probably produce 40 per cent. or 50 per cent. of small on being passed over a screen with holes of, say, 2 inches in diameter. I will take the latter figure. The large coal rejected by the screens should be passed over one or two picking bands and then be delivered gently into barges ; the remainder ought to be screened a second time so as to divide it into several sizes, each of which should be washed separately. The larger sizes, say 33 per cent. upwards of $\frac{1}{2}$ inch in diameter constitute nuts, which in England are sold at very little less than the price of large coal ; the sizes under $\frac{1}{2}$ inch, say 66 per cent., should be made into briquettes, which sell at about the same price as large coal. As the Garo coal is bituminous the quantity of pitch or other agglomerating agent required to make its small into briquettes will be comparatively low.

The cost of making briquettes given at page 201 of "The Mineral Industry" for the year 1897 is as follows :—

100 tons per day.	£.	s.	d.
1 Pressman	0	5	0
2 Boys taking off and loading on trollies ...	0	3	6
1 Man unloading coal...	0	4	0
1 Boy assisting	0	3	0
1 Man at Pitch Mill	0	4	0
1 Do. on first floor	0	4	0
1 Engine driver	0	5	0
1 Stocker	0	4	0
2 Labourers	0	7	0
Total Labour	1	19	6

As the labour cost in India is less than in England, while the cost of skilled supervision is greater, I will assume £1 10*s.* instead of £1 19*s.* 6*d.* per 100 tons.

The cost of producing 100 tons of briquettes thus becomes—

	£.	s.	d.
Labour	1	10	0
Coal 92 tons at 3*s.* 9*d.*	17	5	0
Fuel 2 „ 3*s.* 6*d.*	0	7	0
Pitch 8 „ £2 10*s.*	20	0	0
	39	2	0

This is equal to 7*s.* 9$\frac{3}{4}$*d.* (Rs. 5-13-8) say Rs. 6 per ton. It will be observed that I have allowed 8 per cent. of pitch, or as much as is employed with ordinary coal, since I have no experimental or other data to guide me. I find, however, that this coal makes a very compact and hard little briquette when hammered in the mould in which the briquette is made for testing its calorific value, and I am, therefore, disposed to think that briquettes made from it with 3 per cent. or 4 per cent. of pitch would be amply cohesive enough to resist breakage. If this were found to be the case in practice, say with 4 per cent.

of pitch, then the cost of briquettes would be reduced to Rs. 4.7 6 per ton, and the average cost of the 988 tons to Rs. 4.1 per ton delivered to the market.

Assuming 2 per cent. of rubbish to be picked out of the large coal and 5 per cent. washed out of the small coal, and adding Re. 1·0 per ton for transport by the flotilla, we get the following quantities at the following working costs delivered to the market per 1,000 tons produced from the mine, *viz.* :—

	Quantity. Tons.	Cost per ton. Rs.	Total cost. Rs.
Large Coal	490	3·13	1,868·0
Nuts	159	3·13	606·0
Briquettes	343	6·0	2,058·0
	992	4·9	4,532·0

The screening, picking, washing, and briquette-making plant, together with the appliances for delivering the whole of the produce into barges, will amount to about £45,000 for an output of 1,500 tons per day, and it would be advisable to put them up of sufficient capacity to deal with that output from the first.

The separate items of cost are :—

	£
Washing plant for 800 tons in ten hours	17,000
* Briquette-making plant for 500 tons per day	22,500
Loading appliances	5,000
	£44,500

Instead of accumulating the coal in bunkers capable of holding 500 to 1,000 tons each and loading the barges from the bunkers, it would, I think, be preferable to keep a few spare barges and load the coal into them direct so as to save breakage.

The spare barges would then constitute a portion of the flotilla next referred to.

FLOTILLA.

As you have already purchased the flotilla which conveys the produce from the Dwarra mines and quarries of the Maolong Lime and Coal Company to the various markets, I accept the figures on this subject with which you have supplied me as shown in Appendix II, *viz.*, £250,000, and I assume that this flotilla will be amply sufficient to convey an output of 350,000 tons a year to Chittagong, Calcutta, and the intervening markets.

CAPITAL REQUIRED.

To develop the Colliery to an output of 300,000 to 350,000 tons a year the following capital will thus be required, *viz.* :—

	£
4,000 yards of coal headings at £1 per yard	4,000
Two air shafts 50 yards each at £4	400
Machinery, plant, houses, and labour at the Colliery ...	55,100
Railway	254,600
Screening, washing, briquette-making and loading appliances ...	44,500
Flotilla	250,000
Working Capital	50,000
TOTAL ...	£658,600

* See Schuchtermann and Kremer's letter in Appendix III.

As has been already remarked the low labour costs given above are only possible in a country like India where labour is abnormally cheap. I find from Professor Dunstan's report, for instance, that Bengal Coal raised in shafts sells at an average price of Rs. 2 per ton at the pit's mouth, a price that includes the cost of handling it at the bottom of the shaft and winding it to the surface, as well as the profit accruing to the owners.

The estimated cost of Re. 1 for railway carriage includes only working expenses and repairs and amounts to 0·28*d.* per ton per mile. At an output of 300,000 tons this will provide a sum of £20,000 a year, or £351 per mile for attendance and keeping the railway and the rolling stock in repair, and delivering the coal into the flotilla. This seems to be more than sufficient for the purpose.

A charge of Re. 1 per ton for working and keeping the flotilla in repair and discharging the coal at its destination will provide an equal sum for similar purposes.

Lastly, a charge of 5 per cent. for depreciation on the whole capital, less the working capital, will produce Rs. 4,50,000 or £30,000 a year, or Rs. 1·8 (2*s.*) per ton on the assumed output Adding this figure to the working costs already dealt with, we get the total cost of delivery at Chittagong, Calcutta, &c., inclusive of depreciation on capital expenditure as Rs. 6·1 (8*s.* 1*d.*) per ton.

When referring to the average calorific values and contents in ash of Assam, Bengal and Central Provinces coal already given (p. 9), it will be seen that the calorific value of the first is higher, and its ash lower than the corresponding quantities in the other two coals. It is not surprising, therefore, to find that its selling price at Calcutta and elsewhere much exceeds the selling prices of the two others ; for, whereas Bengal Coal, which is the only one whose competition need be taken into account, sells at a little over Rs. 6 per ton at Calcutta, Assam coal, a mixture of large and small, fetches Rs. 13 8 per ton on account of its better quality, and Cardiff coal Rs. 19 per ton. These figures show the remarkable influence of quality upon selling prices.

In Professor Dunstan's report* two analyses of Makum coal are given, *viz.*, those of samples Nos. 3032 and 7082 with the following results :—

Number.	Calorific Value.	Fixed Carbon.	Ash.	Volatile Matter, inclusive of Moisture.	Sulphur.
3032 ...	6,853	53·28	1·02	45·45	1·07
7082 ...	7,205	47·84	3·66	48·50	4·87

It is not stated in what condition the samples were received as regards moisture, that is to say, whether they were placed in comparatively air-tight receptacles on being taken out of the mine, or whether they had been allowed to dry by standing in the open air, or were dried artificially in any way before being analysed. The samples of Daranggiri coal were packed in boxes immediately after collection, and were damp enough to soften paper when they arrived in my laboratory. After being ground to powder they were allowed to

* Op. cit., p. 14.

stand in the open air of a room without a fire for 36 hours, and two analyses of a mixture of the six samples in equal proportions then give the following results :—

Number.	Calorific Value.	Fixed Carbon.	Ash.	Volatile matter, exclusive of moisture.	Moisture.
1	6,892	47·54	2·96	39·7	9·8
2	6,805	48·10	2·80	39·5	9·6
Average ...	6,848	47·82	2·88	39·6	9·7

The analysis of another portion of the mixture of the six samples which was allowed to dry for about a quarter of an hour in front of the assaying furnace at a temperature of 130° Fahr. gave the following results :—

Calorific Value.	Fixed Carbon.	Ash.	Volatile matter, exclusive of moisture.	Moisture.
7,399	51·26	3·14	44·35	1·25

The last analysis shows that the moisture in this coal is loosely held, and that during dry weather most of it would probably evaporate before the coal was used, thus raising its calorific value above that of Makum coal. In any case it will be conceded that the analysis of this coal, before being dried, compares favourably with both analyses of Makum coal and especially with the first one (3,032) in the above table; and that briquettes made from it with 8 per cent. of pitch (which has a calorific value of 8,400) will have a calorific value of 7,479, in consequence partly of the higher calorific value of the pitch, and partly of the evaporation of the moisture contained in the coal while it is being heated during the process of manufacture.

Assuming, therefore, that the manufactured products of the Daranggiri mines will be sold at Calcutta, Chittagong, and the intervening markets at an average price of not less than Rs. 12 per ton, and that the average cost of the produce delivered to the market at the rate of 1,000 tons per day, or say 300,000 tons per annum will be Rs. 6·1 per ton, the profit will amount to Rs. 5·15 per ton, the annual profit to Rs. 17,81,250 or £118,750, and the available dividend on the whole capital to 18 per cent. per annum ; but if it is found that the briquettes can be made with 4 per cent. of pitch instead of 8 per cent, the profits will be £128,750 and the dividend nearly 19½ per cent.

It might appear more prudent at first sight to send the raw coal into the market and save the outlay for washing and briquette-making plant. I am of opinion, however, from my experience with large collieries in this country, that this would be a short-sighted policy. It is always best to send the produce to the market in the best possible condition, so that it can compete on favourable terms with every rival and thus obtain a command of the market and a ready sale over a wider area than could otherwise be attained.

Besides this, it ought to be borne in mind that briquettes are not liable to spontaneous combustion like the small coal which accumulates in a heap in the hold or bunker of a ship while it is being loaded; and that, consequently, the manufacture of briquettes opens an additional market to the coal from which they are made, from which all unmanufactured coals liable to this objection are necessarily excluded.

OUTPUT OF COAL IN INDIA.

The diagram of the output of Indian Collieries from 1883 to 1902 attached hereto shows that the output has increased at a rapid rate during the last 17 years, and more especially since the year 1898; and although it is certain that fluctuations in the rate of increase will take place in the future, as in the past, it would be contrary to the experience of all other coal-producing countries possessing large undeveloped coalfields if the demand, and consequently the output, did not continue to increase.

I am satisfied, therefore, that Daranggiri coal, which is similar to Makum coal, and better than most of the other Indian coals, will find a ready market, and that there will be no difficulty in disposing of 300,000 tons a year, or of any greater quantity that it may be found desirable or expedient to work in the future.

In considering the question of markets, it is further instructive to observe that nearly the whole output of the Makum Collieries, amounting in 1902 to 220,640 tons, is sold in the interior of the country, and that at present, at any rate, very little of it finds its way to Calcutta, or to any other point on the sea coast.

I am,

Dear Sir,

Yours very truly,

GEO. L. GARTH, ESQ.,
29, THEATRE ROAD,
CALCUTTA.

APPENDIX I.

Following are the opinions of Officers of the Geological Survey of India, regarding the freedom from faults and the economic value of the Coalfield.

Records of the Geological Survey of India, Vol. VII, Pt. 2, p. 58.

Coal in the Garo Hills—By Mr. H. B. Medlicott.

Outcrops.—Several fine outcrops are freely exposed; the one originally reported being by no means the most conspicuous. It occurs in the Garigithem stream,* a furlong or so above the confluence with the Semsang. It is 6 to 8 feet thick, with a steady southerly dip of about 4°, the floor of gneissic rock appearing at a short distance higher up the stream. In the main river, about half a mile above the same confluence,† the seam appears again in equal force, with a low easterly dip. The correct inference, that the seam would be found continuous through the intervening spur, led to the original announcement of the discovery as of "a mountain of coal." It was close to Daranggiri village that I observed the finest outcrop; it is well exposed for many score yards at the base of the cliff along the right bank of the stream, almost horizontal, and with a thickness of full 7 feet throughout, being at the same time very free from shaly partings. Near the south boundary of the field, along the base of the permanent rise of the main range, the coal was found in two places; but here it has the disadvantage of having undergone much disturbance. In the stream a little to the west of the lower village of Baduri, a few yards below the Daranggiri path, the coal is thus seen in full force, but nearly vertical. On the same strike, within a mile of the Semsang, on the path between Baduri and Jankary, the approximate position of the seam is marked by large and abundant débris.

On the evidence of these facts, it is, I think, safe to conclude that there is here a coalfield of considerable extent. The coal-measures are certainly continuous within the area demarcated by the localities I have mentioned, covering roughly about twelve to fifteen square miles; and although the coal itself is probably not co-extensive with the measures, the total quantity must be very large; and it is favourably circumstanced for mining. It lies, however, in the very heart of the Garo hills; but on the most favourable line for a railway, through the gorge of the Semsang, should it ever be thought advisable to undertake such a work. The nummulitic formation with its limestone caps the high ground in the centre of the basin.

Records of the Geological Survey of India, Vol. XV, Pt. 3, p. 178.

The Daranggiri Coalfield, Garo Hills, Assam—By Tom D. LaTouche, B.A.,

Position of the principal seam as regards working.—Except in the south-west corner of the field, where the strata are bent up sharply against the gneiss of the main range, they are either horizontal or dip at very low angles, and there seems to be an absolute freedom from faults over the whole area. The greater part of the seam is above the level of the principal streams so that the coal might be economically extracted, and the mines drained by adits. Moreover, as the rock immediately above the coal is generally a fine clay rock, tolerably impervious to water, the mines would, to a certain extent, be kept dry by it.

That part of the seam which dips below the surface of the rivers would have to be got at by shafts, but the strata above the coal consisting of about 300 feet of sandstone and shales would present no difficulty to the sinking of these. Finally the line of the proposed railway, up the gorge of the Sumesary, passes through the centre of the field, so that if this scheme is ever carried out, there appears to be no reason why the coal of this field should not be worked with facility and profit.

---

* K, No. 1 Plan. † F, No. 1 Plan.

APPENDIX II.

Rough estimate for the necessary Flotilla to carry, say, 300,000 tons yearly from Soorma river to either Chittagong or Calcutta :—

1. We propose to adopt the same tugs and flats as those now in use by the Dwara Flotilla Co., or the Assam-Bengal Flotilla Co., which are found suitable for the transport of coal down the rivers in East Bengal.
2. Each tug to convey two flats or barges of 500 tons each. Draught of tug and flats loaded not to carry 7 feet.
3. We accept Messrs. John King & Co.'s latest tender for this class of tug and flat, *viz.*, Rs. 95,000 per tug, and Rs. 50,000 per flat.

We calculate on being able to load two flats, carrying 1,000 tons daily, and to start one tug with two flat loads daily.

For this loading it will be necessary to have regular coal staiths erected along the bank of the river at the terminus of the railway. The late Mr. Arundell's estimate for coal staiths of this kind proposed to be erected at Dwara, and capable of loading some 1,000 tons daily, was Rs. 1,74,000.

Each trip to Calcutta would take 17 days (*viz.*, 1 day loading, 6 days going down, 3 days unloading, 6 days return journey, and say, 1 day extra to allow for accidents), and each trip to Chittagong would take 14 days (*viz.*, 1 day loading, 5 days going down, 2 days unloading, 5 days return journey and 1 day extra).

The bulk of the coal would probably be taken to Chittagong, so that it will be safe to calculate upon each tug being able to do two trips per month.

Allowing two extra tugs and four extra flats for repairs, accidents, and any delays, we shall require in all 17 tugs and 34 flats for the whole service. These would carry, if necessary, 350,000 tons yearly.

The estimated cost is as follows :—

	Rs.	
Cost of 17 tugs at Rs. 87,500 each	14,87,500	
„ 34 flats, Rs. 50,000 each	17,00,000	
Stores at Rs. 2,000 per tug and Rs. 1,000 per flat ...	68,000	
Cost of staiths at railway terminus, say	2,50,000	
Jetty and land at Chittagong, say	1,50,000	
Workshops at both ends	50,000	
Contingencies	94,500	
	38,00,000	or £ 250,000

APPENDIX III.

SCHUCHTERMANN & KREMER,
MASCHINEN-FABRIK,
Dortmund, den 21 Marz, 1904.

MR. W. GALLOWAY, Mining Engineer, Royal Chambers,
Park Place, Cardiff (England).

DEAR SIR,

IN reply to your letter of the 16th inst., we beg to inform you that the cost of the machinery of a Briquette-making plant giving an output of 500 tons of ready briquettes per working day of 10 hours, including steam-engine, steam-boiler and conveying bands, would amount to Mark 245,000, about. The cost of the building, including chimney, would be about Mark 200,000, consequently the total cost of the plant about Mark 445,000. This estimate is given on the base of German conditions.

We are at your disposition for further particulars, and remain,

Yours very truly,

SCHUCHTERMANN & KREMER.

APPENDIX IV.

Description of the Methods employed in the Analyses of the Daranggiri Coals.

The analyses given on pp. 8 and 14 of this report were made as follows :—

Each sample was divided into two portions, *viz.*, a fine portion which passed through a 60 mesh sieve, and a coarse portion which passed through a 20 mesh sieve, but not through a 60 mesh one.

Moisture.—1 gramme of the coarse coal was heated for one hour at a temperature of 105° C. in a Victor Myer drying bath (toluene being used), cooled between watch glasses in a dessicator and weighed when cold. The loss in weight gave the moisture.

Volatile Matter.—1-2 grammes of the coarse coal were heated in a closed platinum crucible, 40 mm. deep, and 34 mm. diameter at top, for seven minutes over a Bunsen burner, giving a flame 12 c.m. high, the bottom of the crucible being 5 c.m. above the mouth of the burner. Pressure of gas 40 mm. water. The loss in weight gave the volatile matter and moisture, and by subtracting the moisture, as otherwise determined, the volatile matter was ascertained.

Ash.—2-3 grammes of the fine coal were heated in a porcelain dish in a muffle furnace until completely burnt, and the ash weighed after cooling in a dessicator.

Fixed Carbon.—The percentage of fixed carbon was obtained by subtracting the volatile matter, moisture and ash from 100.

Total Sulphur.—1 gramme of the fine coal was mixed with 5 grammes of sodium carbonate, puriss., and heated in a platinum crucible in a muffle furnace at a dull red heat until completely burnt.

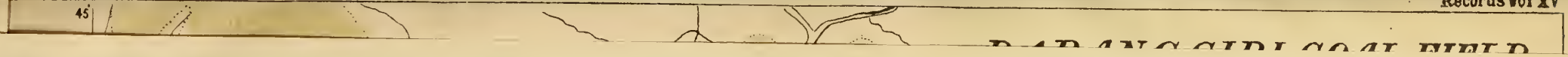
The contents of the crucible were then dissolved in water 1 c.c. bromine added, boiled and filtered. The filtrate was acidified with hydrochloric acid, and the sulphur precipitated as barium sulphate by adding barium chloride. The precipitate was collected on a filter paper, ignited, cooled, and weighed.

After allowing for the weight of the filter paper ash, and for the sulphur contained in the reagents, the weight of the precipitate multiplied by 13·7 gave the percentage of sulphur in the coal.

Calorific Value.—About 1·4 to 1·7 gramme of the fine coal was compressed in a mould into the form of a cylinder, about $\frac{1}{4}$ inch diameter and $\frac{1}{2}$ inch high. This was placed in Rosenhain's improved Thomson Colorimeter, ignited by means of platinum wire heated electrically, and burnt in a current of oxygen. The products of combustion and excess of oxygen escaped at the bottom of the combustion chamber, and bubbled up through about 10 inches of water held in a brass vessel surrounding the combustion chamber.

When the combustion was finished, water was let into the combustion chamber, and then driven out again by oxygen, so as to reduce the whole of the apparatus and water to the same temperature. The rise in temperature was read on a Beckman thermometer graduated to ·01°C. A correction for radiation was added to this, and the whole multiplied by the weight of the water used, plus the water equivalent of the instrument in grammes, and the product divided by the weight of coal used, also in grammes. The result gave the calorific value of 1 gramme of the coal in gramme calories, or of 1 kilogram in kilogram calories.

C. F. J. GALLOWAY,
B.Sc. in Mining, University of Wales.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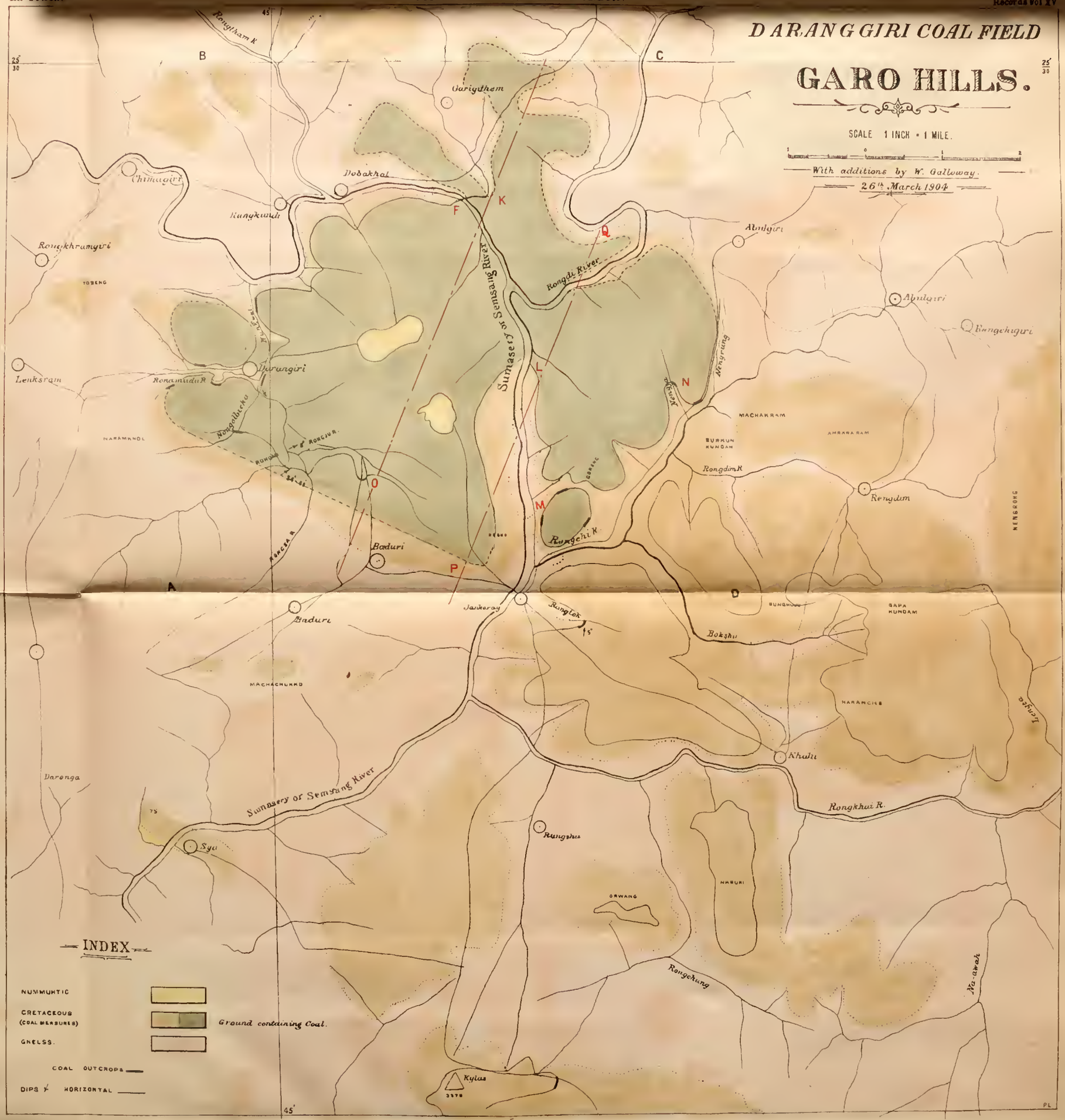

DARANGGIRI COAL FIELD
GARO HILLS.
SCALE 1 INCH = 1 MILE.
With additions by W. Galloway.
26th March 1904
Rongkham R
Garigthem
Chimagiri
Dobakhal
Rongkhamgiri
Rongdi River
Sumasery or Semsang River
Abulgiri
Rongchugiri
Lenksram
Ronamadu R
Durungiri
Nengalbicha
Rongchi R
Baduri
Jankeray
Ronglok
Bokshu
Khalu
Rongkhui R.
Daronga
Sumasery or Semsang River
Syu
Rungshu
Rongchung
Kylus
3378
INDEX
NUMMUHTIC
CRETACEOUS (COAL MEASURES)
GNEISS.
Ground containing Coal.
COAL OUTCROPS
DIPS
HORIZONTAL

SURVEY MAP OF SHIJU IN GARO HILLS

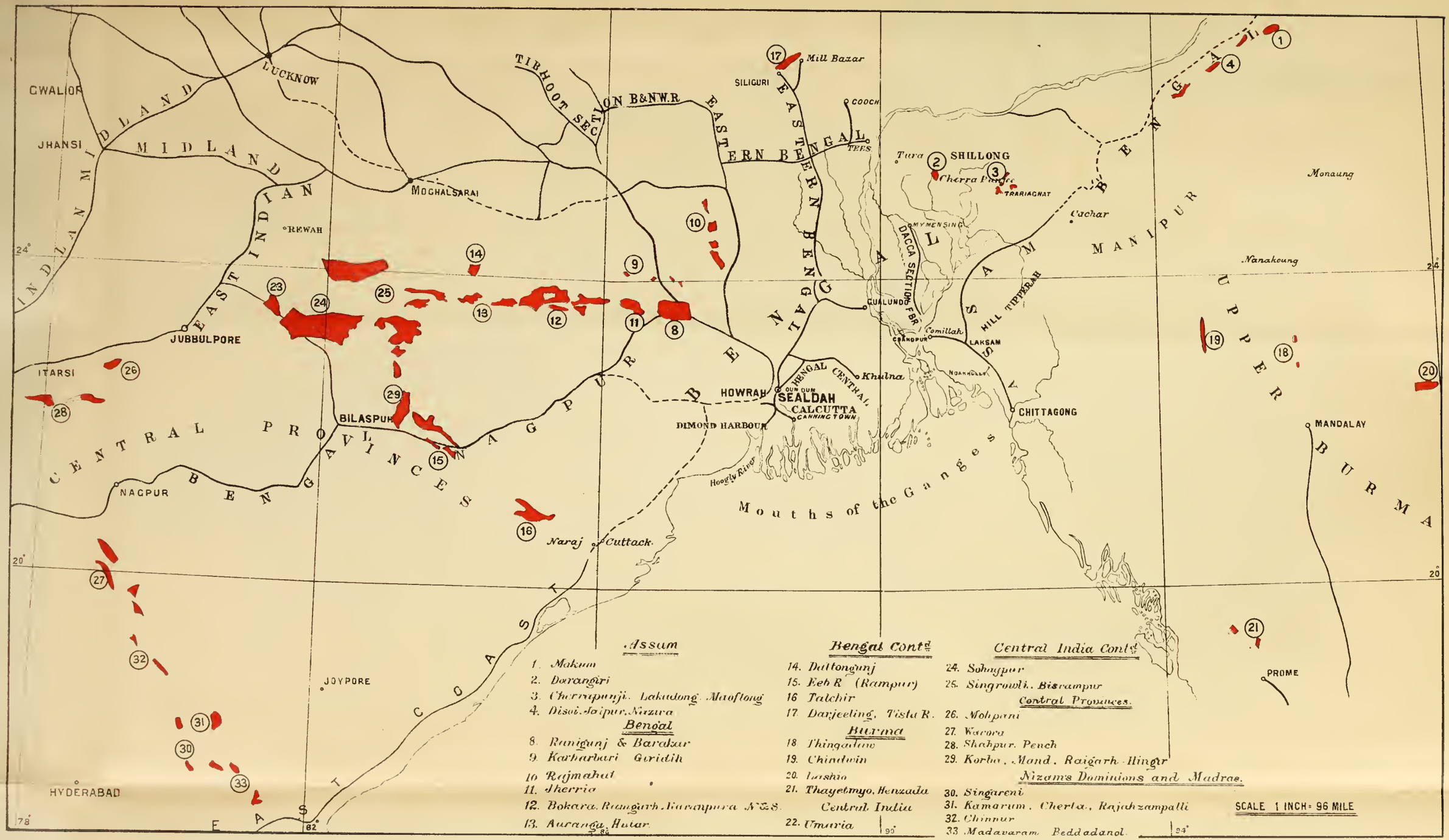
1904

SCALE OF 400 FEET TO AN INCH

SURVEY MAP
OF
TAUTI HILL IN GARO HILLS
1904
SCALE OF 400 FEET TO AN INCH.

LOWLAND
Reg. No. 1328 E.,

POSITIONS OF THE COLLIERIES IN BURMA, ASSAM, BENGAL AND CENTRAL PROVINCES OF INDIA.



Assam

1. Makum
2. Dorangiri
3. Cherrapunji. Lakadong. Maoftong
4. Disoi. Joipur. Nazira

Bengal

8. Raniganj & Baraker
9. Karharbari Giridih
10. Rajmahal
11. Sherria
12. Bokara. Ramgarh. Naranpura N.W.S.
13. Auranga. Hutar
14. Daltongunj
15. Eeh R (Rampur)
16. Talchir
17. Darjeeling. Tista R.

Burma

18. Thingadaw
19. Chindwin
20. Tarshia
21. Thayetmyo. Henzada

Central India

22. Umaria
24. Sohagpur
25. Singrowli. Bisrampur

Central Provinces.

26. Mohpani
27. Warora
28. Shahpur. Pench
29. Korba. Mand. Raigarh. Hingir

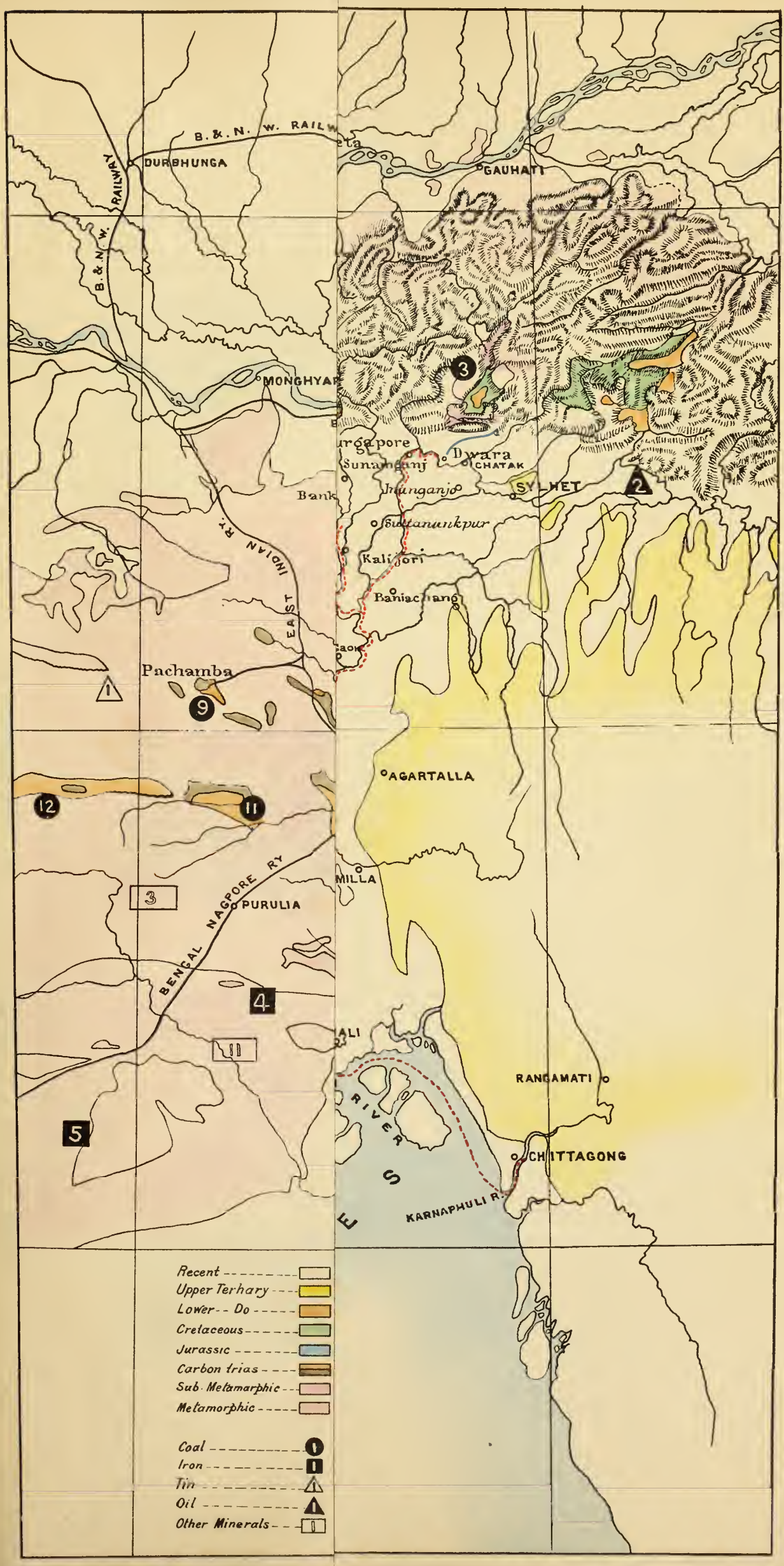
Nizams Dominions and Madras.

30. Singareni
31. Kamarum. Cherla. Rajahzampalli
32. Chinnur
33. Madavaram. Beddadanol.

SCALE 1 INCH = 96 MILE

N. K. Banerji. 1880

PLAN SHOWING THE POSITI COALFIELDS TO CALCUTTA AND CHITTAGONG



PLAN SHOWING THE POSITIONS OF DARANGGIRI AND MAOLONG COALFIELDS AND THE RAILWAY AND STEAMER ROUTES FROM THESE COALFIELDS TO CALCUTTA AND CHITTAGONG

JALPAIGURI
Dalmo
COOCH BEHAR
Barpeta
GOALPARA
GAUHATI
DHUBRI
R. BRAHMAPUTRA
B. & N. W. RAILWAY
DURBHUNGA
E.B.S.RY
PURNEAH
EASTERN BENGAL RY.
E.B.S.RY
RUNGPORE
DINAGEPORE
TURA
Gyabanda
MONGHYAR
BHAGAL PORE
MALDAH
Shushang Durgapore
Nalkabari
Dwara
CHATAK
Shukhai
Sunamganj
Jhinganjo
SYLHET
KONKA RIVER
Netrakona
BOGRA
Banka
Godda
Narulabad
Srirampur
Sultanunkpur
MYMENSINGH
Gaumpur
Kalijori
INDIAN R.
EAST
Mawgarh
Kishorgan
Baniachang
RAMPORE BAULEAH
NYADOOMKA
Ath Gaon
Pachamba
MOORSHEDABAD
Sara
Bhairab Bazar
Damukdia
PUBNA
DACCA SECTION E.B.R.
AGARTALLA
Goalundo
DACCA
MEGNA RIVER
SOORY
GANGES OR PUDDA R.
FARIDPORE
COMILLA
EAST INDIAN RY
EASTERN BENGAL RY.
NUDDEA
KISHNAGHUR
BENGAL NAGPORE RY
PURULIA
BANKOORA
BURDWAN
EAST INDIAN RY
JESSORE
Madareepore
Chandpur
HOOGHLY
E.B.S.RY
KHOOLNA
NOAKHALI
MEGNA RIVER
HOWRAH
CALCUTTA
BURRISAL
BACKERGUNGE
RANGAMATI
MIDNAPORE
E.B.S.RY
E.B.S.RY
MUTLA OR CANNINGTOWN
CHITTAGONG
DIAMOND HARBOUR
TENTULIA
KARNAPHULI R.
HOOGHLY RIVER
SUNDRA
MUTLA R.
BAY OF BENGAL
MOUTHS OF THE GANGES

Recent
Upper Terhary
Lower-- Do
Cretaceous
Jurassic
Carbon trias
Sub Metamarphic
Metamorphic

Coal
Iron
Tin
Oil
Other Minerals

Scale 1 Inch 32 Miles

Fig. 1

Fig 2.

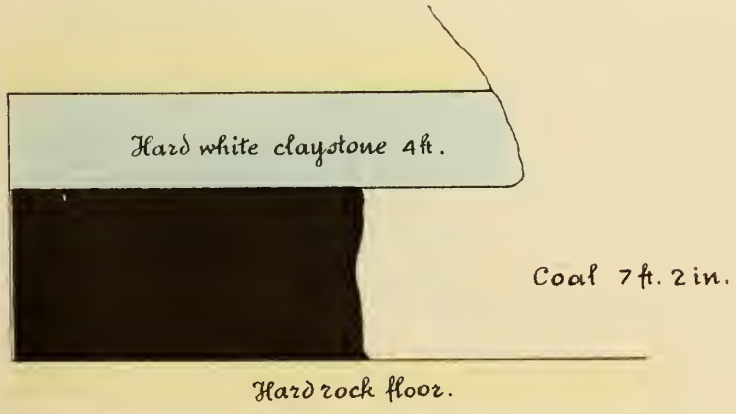


Fig 3.

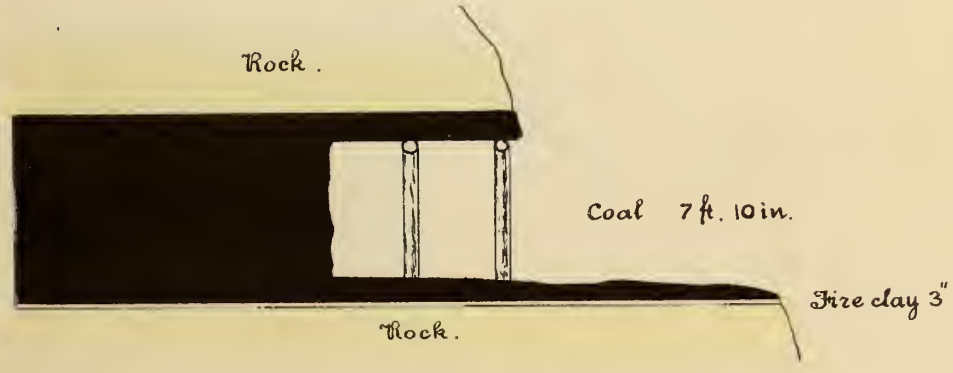


Fig. 4.

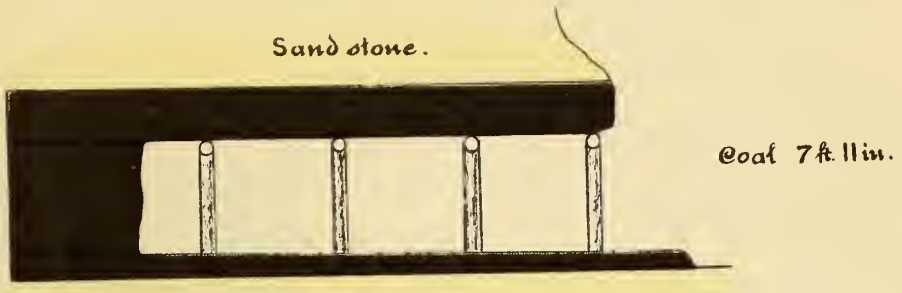


Fig. 5.

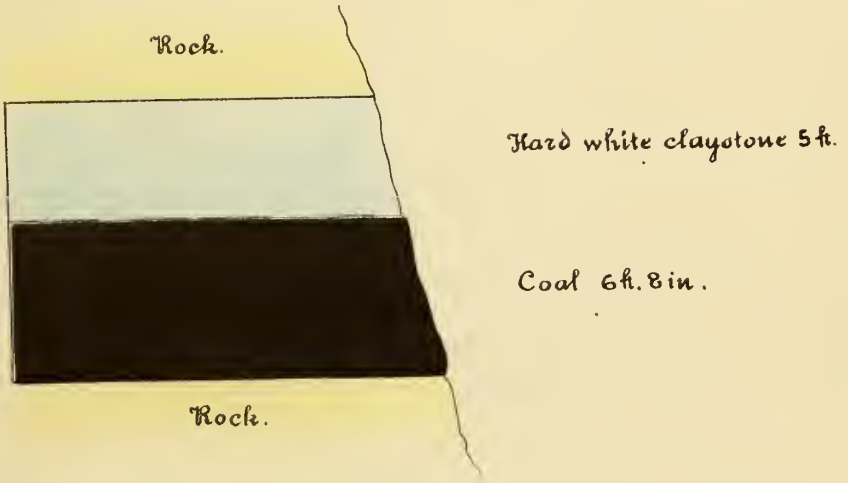


Fig. 6.

Fig. 7.

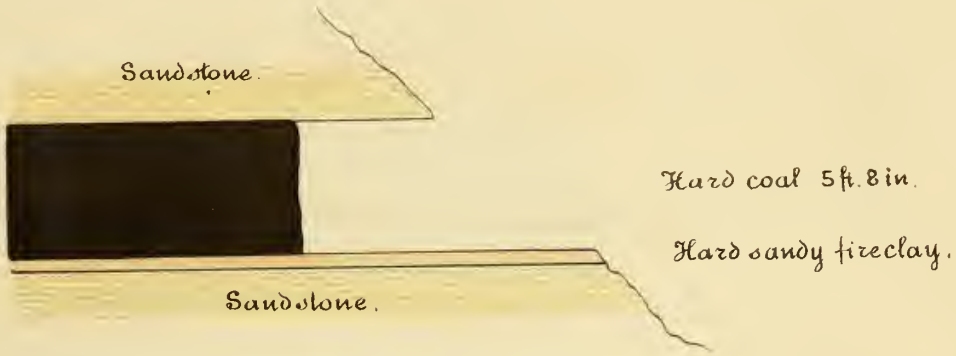


Fig. 8.

Fig 9.

Fig 10.

Sandstone
Hard white clay 4ft
Coal 8ft. 4in.
(Strong & hard)
Very hard sandstone.

Fig. 11.

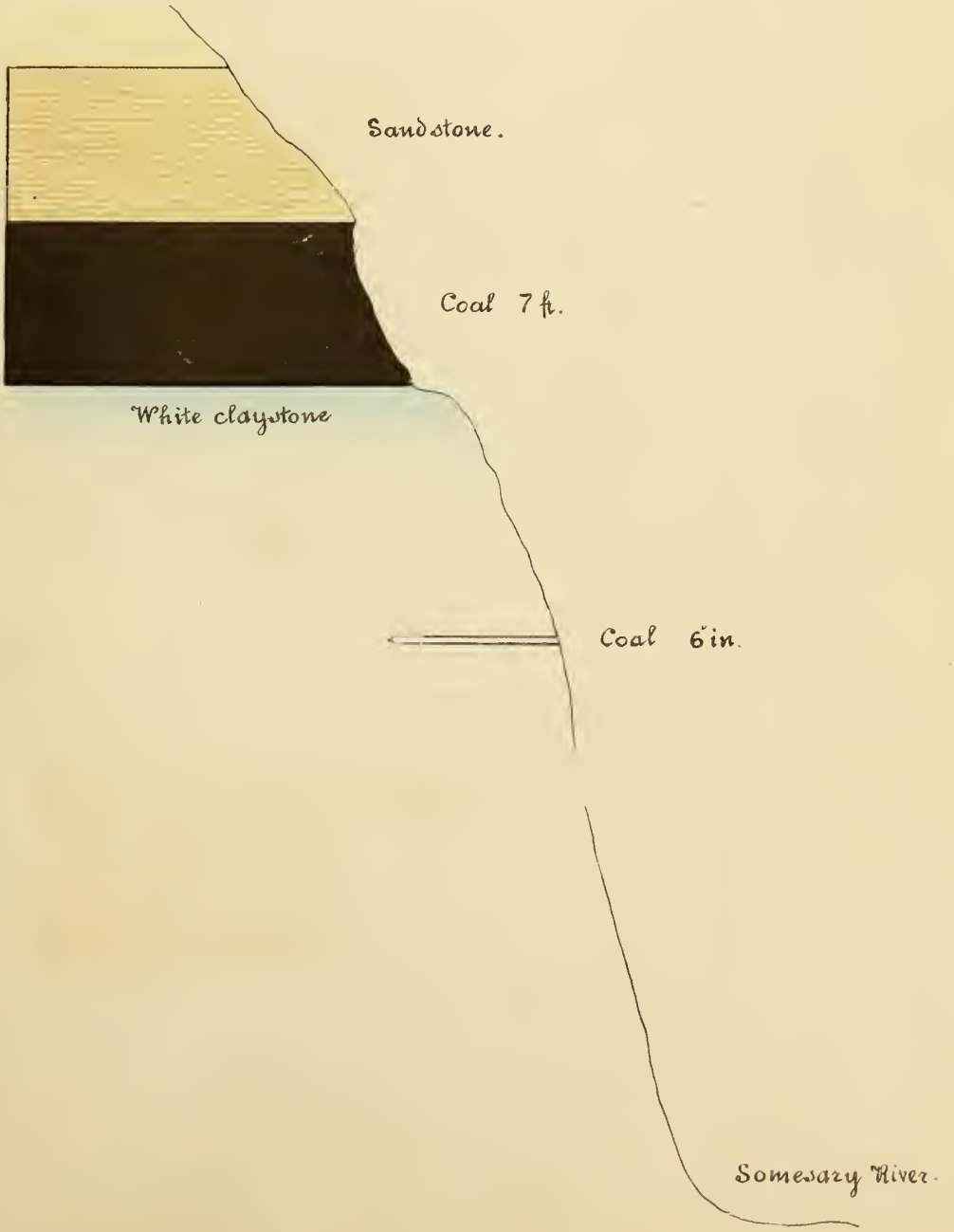
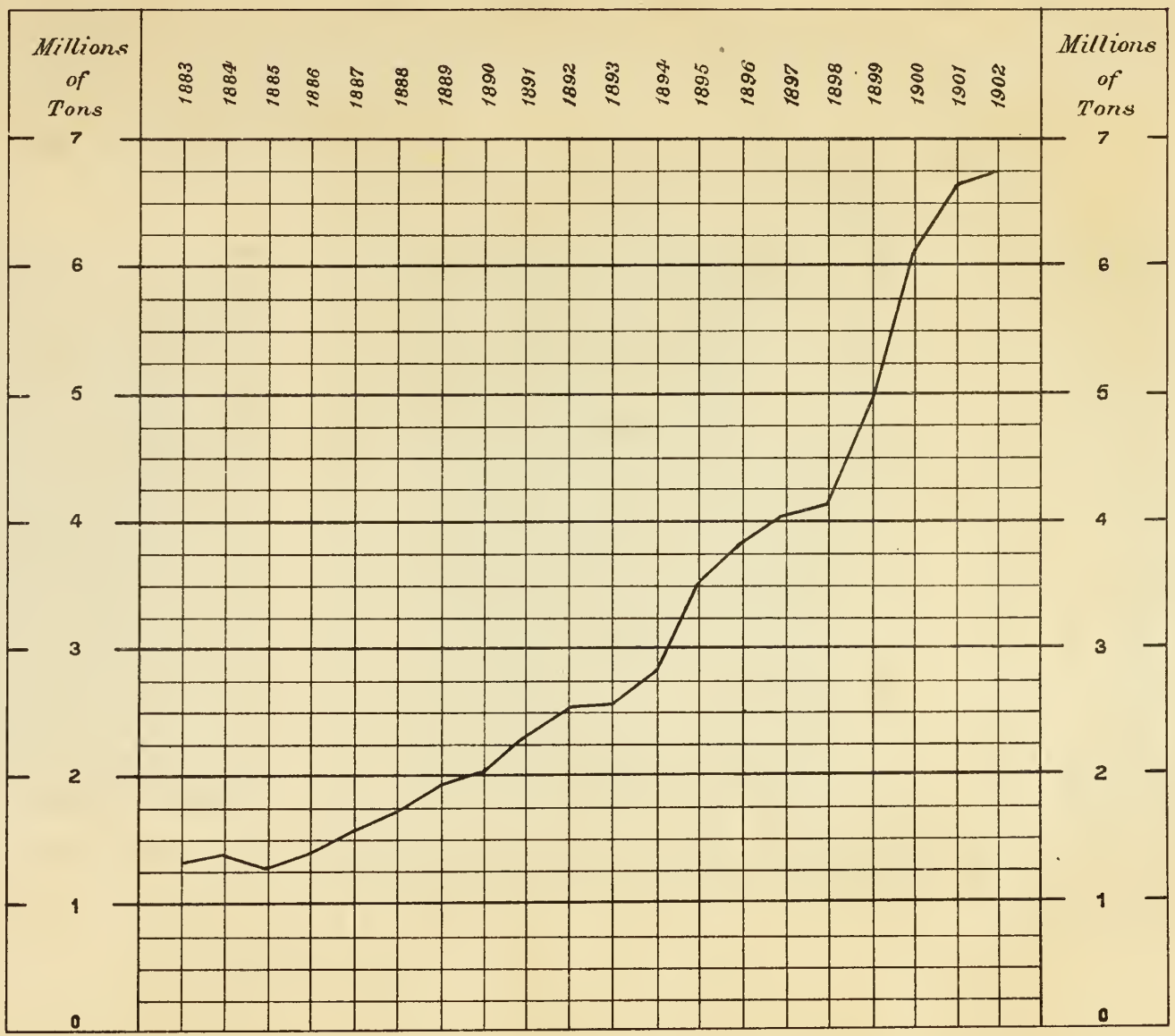

Sandstone.
Coal 7ft.
White claystone
Coal 6in.
Somesazy River.

DIAGRAM SHOWING OUTPUT OF COAL FROM INDIAN MINES

1883 TO 1902



Outcrop at Sijw

No 1. East cliff near debouchure of Hongwall
Outcrop of seam A B.

No 2. The same as No 1 from a point further South
Outcrop of seam A B

No 3. Outcrop of seam in Hongwall
Gallinges B and C

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